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ABSTRACT

The purpose of this document is to identify potentially hazardous substances that may be in use in many school laboratories and to provide an inventory of these substances so that science teachers may take the initiative in providing for the proper storage, handling, use, and if warranted, removal of hazardous materials. The document consists of 11 sections: (1) a discussion of a total science safety program; (2) limitations of the guide; (3) instructions for use of health and safety tables; (4) health and safety tables on explosives, toxic substances, substances identified as corrosive/irritating, and substances identified as known or probable human and animal carcinogens; (5) a list of safety recommendations; (6) information on chemical and biological storage rooms and suggested chemical storage patterns; (7) a list of chemicals (in tabular format), which indicates the storage and use hazards for each chemical; (8) recommendations for textbook publishers and science supply companies; (9) a list of organizations to help science teachers deal with chemicals in the school laboratory; (10) a bibliography; and (11) a form used to evaluate the document. (JN)

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SCHOOL SCIENCE LABORATORIES
A GUIDE TO SOME HAZARDOUS SUBSTANCES

A supplement to the National Institute for Occupational Safety and Health
Manual of Safety and Health Hazards in the School Science Laboratory

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COUNCIL OF STATE SCIENCE SUPERVISORS

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Washington, D.C. 20207

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PREFACE

The purpose of this supplement to the NIOSH **Manual of Safety and Health Hazards in the School Science Laboratory** is to identify certain potentially hazardous substances that may be in use in many school laboratories and to provide an inventory of these substances so that science instructors may take the initiative in providing for the proper storage, handling, use, and, if warranted, removal of hazardous materials.

This document provides lists of explosives, carcinogens, highly toxic, and/or corrosive or irritant chemicals. These lists are not all-inclusive, nor do they address all of the hazards associated with handling chemicals. For example, effects such as central nervous system depression, behavioral modifications, cardiovascular alterations, or allergic reactions which may be associated with exposure to various chemicals have not been addressed. Information on hazards associated with chemicals which have not been addressed, or on chemicals not identified in this document should be obtained from the manufacturer, supplier, local American Chemical Society section members, qualified consultants, or the appropriate government agency.

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Section 1
TOTAL SCIENCE SAFETY PROGRAM

The goal of the Council of State Science Supervisors is to aid in the development of a complete science safety program. The Council advocates the use of chemical substances in the teaching of science courses and believes that student laboratory experiences are essential to a meaningful science curriculum. The Council also recognizes that not all schools can provide conditions necessary for the safe use of all chemicals in their laboratories. The purpose of this document, therefore, is to alert science instructors to the hazards associated with the use of various chemicals found in schools.

Qualified science instructors, teachers who have been trained in laboratory procedures and who have knowledge of potential laboratory hazards, are the foundation of any total school science safety program. There is no substitute for qualified professionals, and only they should be assigned to teach science courses.

Some level of risk is inherent in almost all science activities. Determination of an acceptable level of risk for all planned activities in the science curriculum is the challenge. It is imperative that students learn to identify laboratory risks and follow safe procedures in handling potentially dangerous substances.

The potential hazards of certain substances outweigh their usefulness. In some cases, hazardous substances have come into the schools through governmental surplus property, industrial and college "give-aways," or special purchases for student projects. Often a hazardous reagent has been stored in quantities for a long period of time with only the antique packaging serving as a clue to its age.

The decision to use certain substances in the school laboratory should be based on the best available knowledge of each chemical's particular hazard and the availability of proper handling facilities. Substitutions, either of chemicals or experiments, often can be made to reduce hazards without sacrificing instructional objectives. When the risk outweighs the benefit and no substitute chemical is available, then the experiment should be eliminated.

Section 2
LIMITATIONS OF THIS GUIDE

The list of potentially hazardous substances under discussion here is not all-inclusive, nor does it address all of the hazards which can be encountered when handling chemicals. The substances listed herein were identified by the National Institute for Occupational Safety and Health (NIOSH) in the **Manual of Safety and Health Hazards in the School Science Laboratory** from an examination of the secondary school biology, chemistry, earth science, and physics textbooks, current school supply catalogs, and by the U.S. Consumer Product Safety Commission's (CPSC) Directorate for Health Sciences from an examination of several school science inventories. The Safety Committee of the Council of State Science Supervisors, with the assistance of several toxicologists from state departments of health, the CPSC Health Sciences staff, and other organizations, conducted a literature search to gather information on the hazard associated with exposure to these substances.

Terms used herein are defined as follows:

CARCINOGEN — A substance capable of causing cancer or cancerous growths in mammals.
- "Known" labels indicate that sufficient information exists which shows a definite relationship between exposure to a substance and cancer in humans.
- "Probable" labels indicate there is limited evidence in humans and/or sufficient evidence in experimental animals.

MUTAGEN — A substance capable of causing changes in the genetic material of a cell, which can be transmitted during cell division.

HIGHLY TOXIC — Agents or substances that when inhaled, absorbed or ingested in small amounts can cause death, disablement, or severe illness.

EXPLOSIVE — An unstable substance capable of rapid and violent energy release.

CORROSIVE — A substance that causes destruction of tissue by chemical action on contact.

IRRITANT — A substance that on immediate, prolonged, or repeated contact with normal tissue will induce a local inflammatory reaction.

As new information on chemicals used in school laboratories becomes available, this inventory may be modified to include those chemicals.

Section 3
INSTRUCTIONS FOR USE OF HEALTH AND SAFETY TABLES

Adverse health effects depend upon both the inherent hazard of the substance and the degree of exposure. Therefore, to reduce the risk of adverse health effects, exposure to hazardous substances should be reduced to the lowest possible level, which may in some instances require removal.

Two catagories of potentially hazardous substances have been identified for the purpose of this report:

(1) Substances with hazards that may be greater than their potential usefulness are found in Tables 1 and 2. Table 1 contains chemicals which are explosive, and Table 2 contains chemicals which have been identified as known or probable human carcinogens. It is recommended that these substances **NOT** be used or stored in schools. If it is determined that the use of these substances is vital to the course, special precautions to prevent exposure and/or injury should be employed. Material Safety Data Sheets should be obtained on each chemical delineating particular hazards or handling procedures. In addition, for carcinogens, handling guidelines published by the Federal government should be followed. Those guidelines are published in

(a) **Carcincgens — Regulation and Control,** U.S. Department of Health, Education and Welfare, NIOSH, Publication No. (NIOSH) 77-205, Cincinnati, OH 45226, 1977

(b) **Carcinogens — Working with Carcinogens,** U.S. Department of Health, Education and Welfare, NIOSH, Publication NO. (NIOSH) 77-206, Cincinnati, OH 45226, 1977

(2) Based on current knowledge of the hazards associated with chemicals contained in Tables 3, 4 and 5, their potential usefulness may be outweighed by their associated risks, even when handled with caution and approved safety procedures designed to minimize exposure. Table 3 is a list of substances reported to be animal carcinogens and/or mutagens. Table 4 is a list of substances with a high degree of toxicity. Table 5 is a list of substances that are corrosive or irritating. Storage information is contained in the Science Inventory with special attention given to fire hazards and special storage problems.

The tables are designed to give the chemical name of the substance, a registry identification number, the classified hazard -- although not the only hazard which the substance may present — and space for the instructor to enter the amount presently being stored. The Chemical Abstract Service (CAS) Registry Number has been employed in the tables because synonyms and/or trade names frequently make identification complex. When requesting information about a chemical, the CAS number is a convenient reference.

In order to evaluate the usefulness of this document, WE REQUEST THAT AFTER COMPLETING AN INVENTORY OF CHEMICALS STORED IN THE SCHOOL, THE INSTRUCTOR FILL OUT THE HAZARDOUS SUBSTANCE REMOVAL FORM (p. 55) AND MAIL A COPY TO THE U.S CONSUMER PRODUCT SAFETY COMMISSION WITH AN EVALUATION OF THIS PUBLICATION (p. 57).

Section 4

HEALTH AND SAFETY TABLES

Table 1
EXPLOSIVES

CAUTION: This is not a comprehensive list of all possible explosive chemicals.

The substances in this table are **NOT** recommended for use or storage in schools, except as indicated, unless an absolute need is determined and appropriate safety procedures are instituted.

REMOVAL: Explosives should be removed by trained fire or police bomb squads, or other qualified officials. Limit movement of containers of such chemicals in order to minimize the chance of detonation.

SUBSTANCE	CAS NO.	RECORD OF REMOVAL	WHO, WHERE TAKEN, DATE
Benzoyl Peroxide	94-36-0		
Carbon Disulfide[1]	75-15-0		
Diisopropyl Ether[2]	108-20-3		
Ethyl Ether[2]	60-29-7		
Picric Acid[3]	88-89-1		
Perchloric Acid[4]	7601-90-3		
Potassium metal[2]	7440-09-7		

[1]The flashpoint of carbon disulfide (– 22 °F) is well below room temperature and small amounts of the vapor in air can be explosive.

[2]These chemicals become dangerous upon aging. Ethers and potassium metal can both form explosive peroxides upon exposure to air. Old opened containers of ether should be treated with great caution as should potassium metal not stored under kerosene.

[3]Picric acid should always contain 10-20% water and bottles should be disposed of after two years. Dry picric acid is explosive.

[4]Although the 70% acid/water mixture is not explosive by itself, the use of perchloric acid often leads to the formation of perchlorates which are very explosive.

Table 2
SUBSTANCES IDENTIFIED* AS KNOWN OR PROBABLE HUMAN CARCINOGENS

CAUTION: This is not a comprehensive listing of all chemicals having substantial evidence of carcinogenicity. Further, each substance listed here may have additional health hazards.

These substances are **NOT** recommended for use or storage in schools unless an absolute need is determined and appropriate use and storage safety procedures are instituted. If it is determined that there is a definite need to use one of these carcinogenic chemicals, obtain additional information on the risk involved. Information on many carcinogenic chemicals can be obtained from NIOSH or CPSC. Ask for the NIOSH criteria document on the chemical of interest by writing to NIOSH, Publications Dissemination DSDTT, 4676 Columbia Parkway, Cincinnati, OH 45226, or write for additional information to CPSC, Directorate for Health Sciences, Washington, D.C. 20207. (For more information, contact the groups listed in Section 9 of this document.) REMEMBER — Some carcinogens are more potent than others and risk increases with **level** and **duration** of exposure.

REMOVAL: These substances should be removed by health authorities or a licensed commercial company. All state, local and federal regulations must be adhered to in the removal process. Once removed, the substances should not reenter the school. Instructions should be added to the procedures for ordering chemicals to make sure that, once removed, these chemicals are not reordered.

KNOWN CARCINOGENS	CAS NO.	AMOUNT
Arsenic Powder**	7440-28-2	
Arsenic Pentoxide	1303-28-2	
Arsenic Trichloride	7784-34-1	
Arsenic Trioxide	1327-53-3	
Asbestos	1332-21-4	
Benzene	71-43-2	
Benzidine	92-87-5	
Chromium Powder**	7440-47-3	
Chromium (VI) Oxide	1333-82-0	
Lead Arsenate	7784-40-9	
Sodium Arsenate	7631-89-2	
Sodium Arsenite	7784-46-5	
PROBABLE CARCINOGENS	**CAS NO.**	**AMOUNT**
Acrylonitrile	107-13-1	
Cadmium Powder**	7440-43-9	
Cadmium Chloride	10108-64-2	
Cadmium Sulfate	10124-36-4	
Carbon Tetrachloride	56-23-5	
Chloroform	67-66-3	
Ethylene Oxide	75-21-8	
Nickel Powder**	7440-02-0	
o-Toluidine	95-53-4	

*Based on the International Agency for Research on Cancer (IARC) classification. "Known" carcinogens are IARC Group 1; "Probable" carcinogens are IARC Groups 2A and 2B.

**Evidence for the carcinogenicity of these metals is derived from occupational exposure studies. Although it is uncertain whether the metal or a metal compound(s) is responsible, only respirable particulates are thought to be of concern.

Table 3
SUBSTANCES REPORTED AS ANIMAL CARCINOGENS* OR MUTAGENS**

ANIMAL CARCINOGENS: Reports on the extent of the hazard to humans are not complete as of this edition. Substances that are animal carcinogens should be regarded as posing a carcinogenic risk to humans and should be used with appropriate caution.

MUTAGENS: The extent of the hazard to humans associated with exposure to mutagens is less clear than it is with carcinogens. However, it is recommended that similar (to that exercised in handling carcinogens) caution should be exercised in handling substances which are mutagenic.

Substances are identified as KNOWN ANIMAL CARCINOGENS or MUTAGENS

SUBSTANCE	CAS NO.	ANIMAL CARCINOGENS	MUTAGENS	AMOUNT
Acetamide	60-35-5	●	●	
Acridine Orange	494-38-2		●	
Ammonium Chromate	7788-98-9		●	
Ammonium Dichromate Ammonium Bichromate	7789-09-5		●	
Aniline (or any of its salts)	142-04-1	●		
Anthracene	120-12-7		●	
Antimony Oxide	4327-33-9		●	
Beryllium Carbonate	66104-24-3	●	●	
Cobalt Powder	7740-48-4		●	
Colchicine	64-86-8		●	
1,2-Dichloroethane (Ethylene Dichloride)	107-06-2	●	●	
1,4-Dioxane (p-Dioxane)	123-91-1	●		
Formaldehyde	50-00-0	●	●	
Hydroquinone	123-31-9		●	
Indigo Carmine	860-22-0		●	
Lead Diacetate	301-04-2	●	●	
Nickel (II) Acetate	373-02-4	●		
Osmium Tetraoxide	20816-12-0		●	
Potassium Chromate	7789-00-6		●	
Potassium Permanganate	7722-64-7		●	
Pyrogallic Acid	87-66-1		●	
Silver (I) Nitrate	7761-88-8		●	
Sodium Azide	26628-22-8		●	
Sodium Dichromate Dihydrate	7789-12-0		●	
Sodium Nitrate	7631-99-4		●	
Sodium Nitrite	7632-88-3		●	
Thioacetamide	62-55-5	●	●	
Toluene	108-88-3		●	
Urethane (Ethyl Carbamate)	51-79-6	●	●	

*Based on IARC classification or the National Toxicology Program testing classifications.

**Based on IARC classification, the National Toxicology Program testing classification, or the Registry of Toxic Effects of Chemical Substances (following review of citations by CPSC).

Table 4
HIGHLY TOXIC SUBSTANCES THAT SHOULD ONLY BE USED WITH CAUTION AND APPROVED SAFETY PROCEDURES

Substances in Table 4 are highly toxic as defined by the Federal Hazardous Substances Act (FHSA). Very small amounts of these chemicals may cause immediate, acutely toxic reactions. All necessary precautions should be taken to limit exposure to these highly toxic chemicals and substitutes for such chemicals should be used whenever possible.

The FHSA uses the LD_{50} and LC_{50} as a measure of the acute toxicity of a substance. The FHSA defines a highly toxic substance as one where the LD_{50} is 50 mg/kg or less when orally administered or where the LC_{50} is 200 ppm or less when a gas or vapor is inhaled. The LD_{50} is the dose of a substance that produces death in 50% of a group of laboratory animals. The LC_{50} is the vapor concentration of a substance that produces death in 50% of the animals. Although these measures of lethality can be influenced by a variety of factors, historically they have provided a measure of toxicity which can be used in estimating the comparative safety of substances. The LD_{50} values in this table are determined for the most part following oral administration of the chemical to rats and are expressed in milligrams per kilogram (mg/kg). The LC_{50} is expressed in parts per million (ppm). The lowest LD_{50} or LC_{50} reported in the literature is shown for each substance.

SUBSTANCE	CAS NO.	LD_{50} (mg/kg) or LC_{50} (ppm)	AMOUNT
Adrenaline	51-43-4	50 mg/kg	
Barium Hydroxide	17194-00-2	5 to 50 mg/kg	
Chlorine	7782-50-5	137 ppm	
Colchicine	64-86-8	50 mg/kg	
Mercury	7439-97-6	Mercury presents a special type of hazard. Due to acute and chronic neurotoxicity of mercury vapors, the Occupational Safety and Health Administration has set the Acceptable Ceiling Concentration* at 100 micrograms per cubic meter.	
Mercuric Chloride	7487-94-7	10 mg/kg	
Mercuric Iodide	7774-29-0	40 mg/kg	
Mercuric Nitrate	7783-34-8	**	
Mercuric Oxide	21908-53-2	18 mg/kg	
Mercuric Sulfate	13766-44-4	**	
Nicotine	54-11-5	24 mg/kg	
Osmium Tetraoxide	20816-12-0	14 mg/kg	
Phosphorus (White)	7723-14-0	4.8 mg/kg	
Phosphorus Pentoxide	1314-56-3	9.7 ppm	
Potassium Cyanide	151-50-8	***	
Potassium Periodate	7790-21-8	48 mg/kg	
Silver Cyanide	506-64-9	***	
Sodium Cyanide	143-33-9	4 mg/kg	

*Acceptable Ceiling Concentration is the level which cannot be exceeded at anytime during an eight hour work shift.

**Toxicity is expected to be similar to other mercuric salts.

***Toxicity is expected to be similar to Sodium Cyanide.

Table 5
SUBSTANCES IDENTIFIED* AS CORROSIVE OR IRRITATING THAT CAN BE USED WITH CAUTION AND APPROVED SAFETY PROCEDURES

For those substances labeled corrosive, great care should be taken to prevent contact with the skin and especially with the eyes, since blindness or impaired vision could result. For those chemicals labeled as irritants, care should be taken to avoid skin and eye contact; for volatile substances, additional care should be exercised to avoid inhalation of vapors.

SUBSTANCE	CAS NO.	CORROSIVE	IRRITANT	AMOUNT
Acetaldehyde	75-07-0		●	
Acetic Acid	64-19-7	●		
Acetic Anhydride	108-24-7		●	
Aluminum Chloride	7446-70-0	●		
Ammonia	1336-21-6		●	
Ammonium Dichromate	7789-09-5	●		
Ammonium Oxalate	14258-49-2	●		
Antimony Pentachloride	7647-18-9	●		
Antimony Oxide	1309-64-4		●	
Antimony Trichloride	10025-91-9	●		
Bismuth Trichloride	7787-60-2	●		
Bromine	7726-95-6	●		
Calcium Carbide	75-20-7	●		
Calcium Fluoride	7789-75-5		●	
Calcium Oxide	1305-78-8	●		
Catechol (pyrocatechol)	120-80-9		●	
Chlorine**	7782-50-5	●		
Cupric Bromide	7789-45-9	●		
Cupric Chloride	1344-67-8		●	
Cupric Nitrate	10031-43-3		●	
Cupric Sulfate	7758-98-7		●	
p-Dichlorobenzene	106-46-7		●	
Diethyl Phthalate	84-66-2		●	
Ethyl Methacrylate	97-63-2		●	
Ferric Chloride	7705-08-0		●	
Hexachlorophene	70-30-4		●	
Hydrochloric Acid	7647-01-0	●		
Hydrofluoric Acid	7664-39-3	●		
Hydrogen Peroxide (30%)	7722-84-1		●	
Hydrogen Sulfide	7783-06-4		●	
Hydroquinone	123-31-9	●		
Iodine (crystals)	7553-56-2		●	
Lead Carbonate	598-63-0		●	

*According to NFPA and RTECS
**Highly toxic substances included here for their corrosive or irritant characteristics.

Table 5, continued — Substances identified* as CORROSIVE or IRRITANT

SUBSTANCE	CAS NO.	CORROSIVE	IRRITANT	AMOUNT
Lithium	7439-93-2	●		
Methyl Ethyl Ketone	78-93-3		●	
Methyl Methacrylate	80-62-6		●	
Methyl Salicylate	119-36-8		●	
Naphthalene	91-20-3		●	
Nitric Acid	7697-37-2	●		
Oxalic Acid	144-62-7	●		
Phosphorus (White)**	7723-14-0	●		
Phosphorus Pentoxide**	1314-56-3	●		
Phthalic Anhydride	85-44-9		●	
Potassium Chromate	7789-00-6	●		
Potassium Cyanide**	151-50-8	●		
Potassium Fluoride	7789-23-3	●		
Potassium Metal	7740-09-7	●		
Potassium Hydroxide	1310-58-3	●		
Potassium Permanganate	7722-64-7		●	
Sodium Metal	7440-23-5	●		
Sodium Cyanide**	143-33-9	●		
Sodium Ferrocyanide	13601-19-9	●		
Sodium Hydroxide	1310-73-2	●		
Sodium Sulfide	1313-84-4		●	
Disodium Hexafluorosilicate (Sodium Silicofluoride)	16893-85-9	●		
Stannic Chloride	7646-78-8	●		
Sulfuric Acid	7664-93-9	●		
Sulfuric Acid Fuming	8014-95-9	●		
Titanium Trichloride	7705-07-9		●	
Toluene	108-88-3		●	
Trichlorotrifluoroethane	76-13-1		●	
Turpentine	8006-64-2		●	

*According to NFPA and RTECS
**Highly toxic substances included here for their corrosive or irritant characteristics.

Section 5
SAFETY RECOMMENDATIONS

WORK HABITS

- Never work alone in a science laboratory or storage area.
- Never eat, drink, smoke, chew gum or tobacco in a science laboratory or storage area. Do not store food or beverages in the laboratory environment.
- Never pipette by mouth.
- Wash hands before and after work in a science laboratory, and after spill cleanups.
- Restrain loose clothing (e.g. sleeves, full cut blouses, neckties etc.), long hair and dangling jewelry.
- Tape all Dewar flasks.
- Never leave heat sources unattended (e.g. gas burners, hot plates, heating mantles, sand baths, etc.).
- Do not store reagents and/or apparatus on lab bench, and keep lab shelves organized.
- Never place reactive chemicals (in bottles, beakers/flasks, wash bottles, etc.) near the edges of a lab bench.
- Use a fume hood when working with volatile substances.
- Never lean into the fume hood.
- Do not use the fume hood as a storage area.
- Obtain and read the Material Safety Data Sheets (MSDS) for each chemical before beginning any experiment.
- Analyze new lab procedures in advance to pinpoint hazardous areas.
- Analyze accidents to prevent repeat performances.
- Protection should be provided for not only the lab worker but also the lab partner working nearby.
- Do not mix chemicals in the sink drain.
- Always inform co-workers of plans to carry out hazardous work.
- Record who worked with what, when, and how long in order to allow meaningful retrospective contamination studies.
- Conduct regular in-house safety and health inspections with an emphasis on improvement rather than guilt.
- Inform lab occupants about the alarm bell and what to do if it sounds.
- Carry out regular fire or emergency drills with critical reviews of the results.
- Have actions pre-planned in case of an emergency (e.g. what devices should be turned off, which escape route to use, a personnel meeting place outside the building, a person designated to authorize re-entry into the building).
- Lab personnel should have recent training in first aid, CPR etc.

SAFETY WEAR

- ANSI (or equivalent standard) approved eye or face protection should be worn continuously.
- Gloves should be worn which will resist penetration by the chemical being handled and which have been checked for pin holes, tears, or rips.
- Wear a laboratory coat or apron to protect skin and clothing from chemicals.
- Footwear should cover feet completely; no open-toe shoes.

FACILITIES AND EQUIPMENT

- Have separate containers for trash and broken glass.
- Never block any escape routes, and plan alternate escape routes.
- Never block a fire door open.
- Never store materials in lab or storage area aisles.
- All moving belts and pulleys should have safety guards.
- Instruct lab personnel in the proper use of the eye-wash fountain, emphasizing rolling of the eye-balls, and turning eyelids "inside-out".
- Ensure that eye-wash fountains will supply at least 15 minutes of water flow.
- Sample breathing air space for measurement of possible contaminants, and keep good records.

- Regularly inspect fire blankets for rips and holes and keep good records of the inspections.
- Regularly inspect safety showers and eye-wash fountains and keep records of inspections.
- Keep up-to-date emergency phone numbers posted next to the phone.
- Place fire extinguishers near an escape route, not in a "dead end".
- Regularly maintain fire extinguishers, maintain records, and train personnel in the proper use of extinguishers through actual fire situations.
- Acquaint personnel with the meaning of "Class A fire", "Class B fire", etc., and how they relate to fire extinguisher use.
- Regularly check hood for proper draft; also check that exhaust air from an external hood vent is not redrawn into room air.
- Secure all compressed gas cylinders when in use and transport them secured on a hand truck.
- Install chemical storage shelves with lips, and never use stacked boxes in lieu of shelves.
- Only use an explosion-proof refrigerator for lab storage.
- Have appropriate equipment and materials available for spill control; replace when it becomes dated.

PURCHASING, USE, AND DISPOSAL

- If possible, purchase chemicals in class-size quantities only.
- Label all chemicals accurately with date of receipt, or preparation, initialed by the person responsible, and pertinent precautionary information on handling.
- Generally, bottles of chemicals should not remain unused on shelves in the lab for more than one week, in the store room near the lab unused for more than one month, or in the main stockroom unused for more than one year.
- Follow all directions for disposing of residues and unused portions of reagents.
- Properly store flammable liquids in small quantities in containers with a provision for bonding to receiving vessels when the liquid is transferred.
- Never open a reagent package until the label has been read and completely understood.
- Have a Material Safety Data Sheet on hand before using a chemical.
- Prepare a complete list of chemicals of which you wish to dispose.
- Classify each of the chemicals on the disposal list into a hazardous or non-hazardous waste chemical. (Check with the local environmental agency office for details.)
- Unlabeled bottles (a special problem) must be identified to the extent that they can then be classified as hazardous or non-hazardous wastes. (Some landfills will analyze a mystery bottle for a fee, if it is shipped to the landfill in a separate package, labeled as a sample, and accompanied by a letter also identifying it as a sample, with instructions to analyze the contents sufficiently to allow proper disposal).

SUBSTITUTIONS

- Reduce risks by diluting substances instead of using concentrates.
- Use micro/semi-micro techniques instead of macro-techniques.
- Use films, videotapes, and other methods rather than experiments involving hazardous substances.
- Undertake all substitutions with extreme caution.

CLASSES

— All science teachers should complete a science safety course such as "Safety in the School Science Laboratory." It has been developed cooperatively by the Council of State Science Supervisors (CS^3) and the National Institute for Occupational Safety and Health (NIOSH). For information concerning this course, please contact the local state science supervisor or Mrs. Glenda White, Division of Training and Manpower Development, NIOSH, 4674 Columbia Parkway, Cincinnati, OH 45226.

— Other chemical safety training courses are offered by commercial organizations, universities, professional societies and trade associations.

— All science teachers should complete a first aid and CPR course offered by the American Red Cross.

EMERGENCY TELEPHONE NUMBERS

Post these numbers in a conspicuous place near the telephone:

Fire _____

Police _____

Rescue Squad _____

Hospital _____

Poison Control Center _____

The local fire department should be regularly informed of current hazardous situations in the lab, and yearly visits by the fire chief are recommended. Nearby hospitals should be aware of current specifics of hazardous chemicals used in the lab. Local physicians should be aware of proper treatments for exposures to chemicals used in the lab.

OFFICIAL INSPECTIONS

Although few schools have the necessary test instruments and personnel trained to conduct a thorough inspection, local health authorities will be able to determine whether or not science laboratory facilities, equipment and storage areas are safe for the substances being used in the program. In the event local authorities are unable to perform this service, consultants from commercial companies are available to make inspections and perpare written reports on their findings.

DAILY INSPECTIONS

Official inspections do not relieve the science instructor of the responsibility of daily and other periodic inspections necessary to maintain a high standard of health and safety for the protection of students and school property.

REFERENCES

Many helpful suggestions may be found in the NIOSH publication **Safety in the School Science Laboratory.**

Section 6
CHEMICAL AND BIOLOGICAL STORAGE ROOMS AND SUGGESTED CHEMICAL STORAGE PATTERNS

One chemical/biological storage room under the supervision of a qualified person is essential for each school. The storage room should have adequate security. Safety facilities should include the following:

- Fire extinguishers of the approved type, including sand and soda positioned near an escape route.
- Spill control and clean-up materials.
- Master control shut-off valves for gas, water and electricity.
- Approved eye/face wash.
- Shower
- Smoke detector.
- Forced ventilation from floor to ceiling with exhaust above roof level.
- Lip-edged shelving secured to wall with top shelf below eye level.
- Safety cabinets for specific groups of compatible substances.
- A communication system to the main office or emergency center.

The alphabetical method of storing chemicals presents hazards because chemicals which react violently with each other may be stored in close proximity. The J. T. Baker Chemical Company has devised a simple color coding scheme to address this problem. The code includes both solid and striped colors which are used to designate specific hazards as follows:

Red	— Flammability hazard: Store in a flammable chemical storage area.
Red Stripe	— Flammability hazard: Do not store in the same area as other flammable substances.
Yellow	— Reactivity hazard: Store separately from other chemicals.
Yellow Stripe	— Reactivity hazard: Do not store with other yellow coded chemicals; store separately.
White	— Contact hazard: Store separately in a corrosion-proof location.
White Stripe	— Contact hazard: Not compatible with chemicals in solid white catagory.
Blue	— Health hazard: Store in a secure poison area.
Orange	— Not suitably characterized by any of the foregoing categories.

Once the chemicals are sorted according to ther color codes, sorting into organic and inorganic classes within a color should occur. The Flinn Chemical Catalog Reference Manual suggests organic and inorganic groupings which are further sorted into compatible families. The compatible families suggested* are:

INORGANIC

1. Metals, hydrides
2. Halides, sulfates, sulfites, thiosulfates, Phosphates, halogens
3. Amides, nitrates** (except ammonium nitrate), nitrites**, azides**, nitric acid
4. Hydroxides, oxides, silicates, carbonates, carbon
5. Sulfides, selenides, phosphides, carbides, nitrides
6. Chlorates, perchlorates**, perchloric acid** chlorites, hypochlorites, peroxides**, hydrogen peroxide
7. Arsenates, cyanides, cyanates
8. Borates, chromates, manganates, permanganates
9. Acids (except nitric)
10. Sulfur, phosphorus**, arsenic, phosphorus pentoxide**

ORGANIC

1. Acids, Anhydrides, peracids
2. Alcohols, glycols, amines, amides, imines, imides
3. Hydrocarbons, esters, aldehydes
4. Ethers**, ketones, ketenes, halogenated hydrocarbons, ethylene oxide
5. Epoxy compounds, isocyanates
6. Peroxides, hydroperoxides, azides**
7. Sulfides, polysulfides, sulfoxides, nitriles
8. Phenols, cresols

Using a combination of the J. T. Baker and Flinn Scientific storage schemes should eliminate chemical incompatibilities in the chemical storage room.

On the opposite page is a suggested arrangement of the compatible chemical families on the shelf areas of a chemical storage room. This suggested arrangement is taken from the Flinn Chemical Catalog Reference Manual.* It should be remembered that storage shelves should not be above eye level and the chemicals marked with a double asterisk (**) deserve special attention due to their pctential instability. Additional information on chemical incompatabilities can be found on p. 45.

Be sure to follow local fire codes when storing flammable chemicals in separate cabinets.

STORAGE SUGGESTIONS

1. Avoid floor chemical storage (even temporary)
2. No top shelf chemical storage
3. No chemic stored above eye level
4. Shelf assemblies are firmly secured to walls. Avoid island shelf assemblies.
5. Provide anti-roll lips on all shelves
6. Ideally shelving assemblies would be of wood construction
7. Avoid metal, adjustable shelf supports and clips. Better fixed, wooden supports.
8. Store acids in dedicated acid cabinet. Store nitric acid in that same cabinet **only** if isolated from other acids. Store both inorganic and some organic acids in the acid cabinet.
9. Store flammables in a dedicated flammables cabinet.
10. Store severe poisons in a dedicated poisons cabinet.

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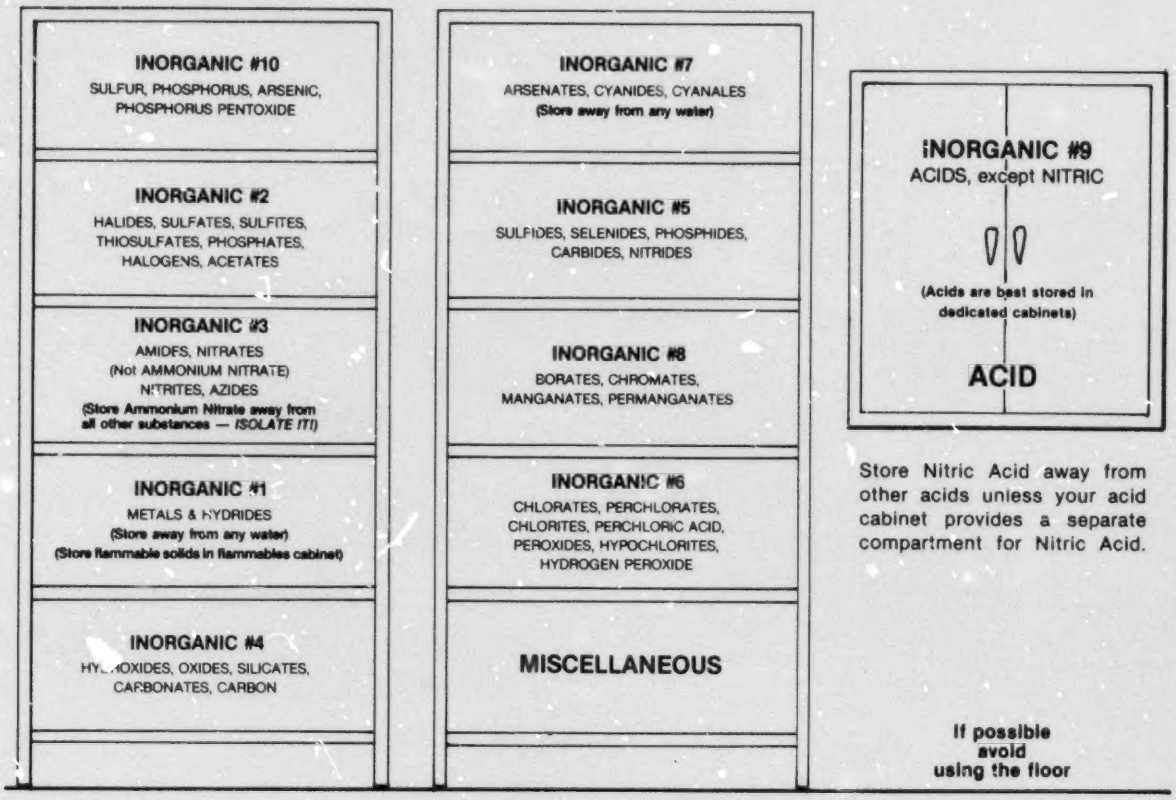
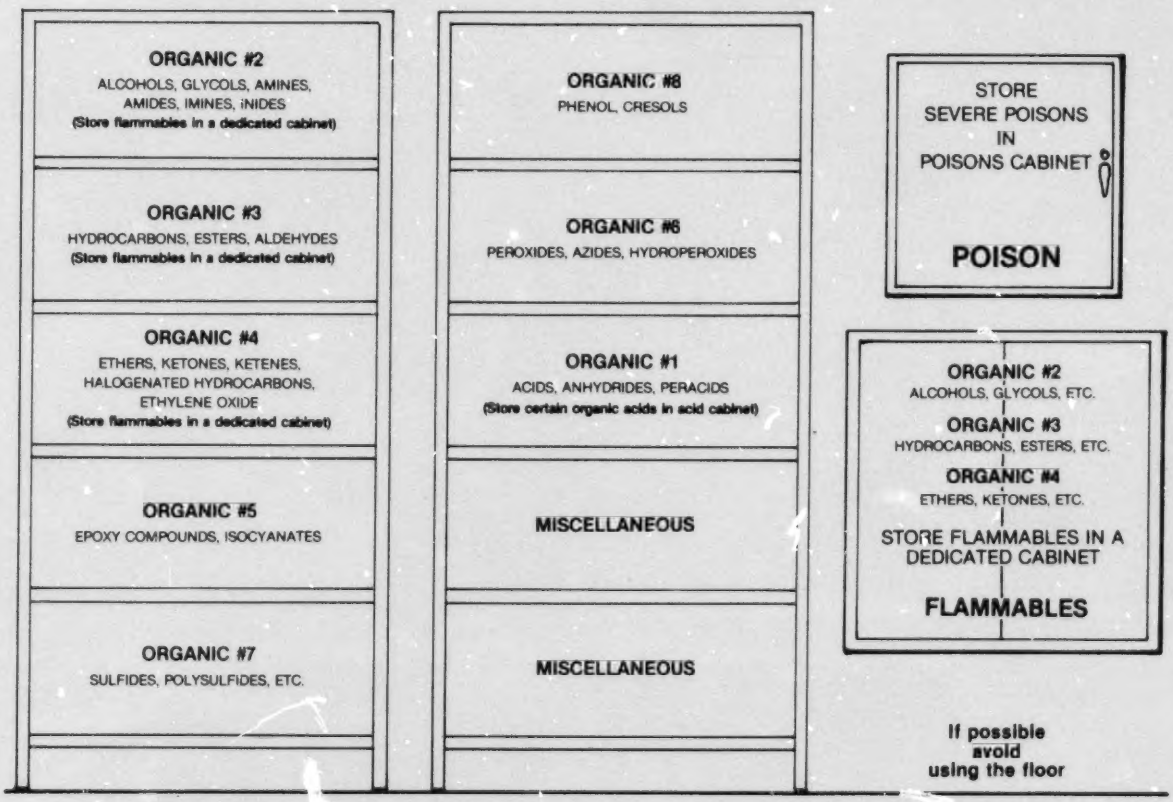
**These chemicals deserve special attention due to their potential instability.

SUGGESTED SHELF STORAGE PATTERN — INORGANIC


INORGANIC #10
SULFUR, PHOSPHORUS, ARSENIC, PHOSPHORUS PENTOXIDE
INORGANIC #2
HALIDES, SULFATES, SULFITES, THIOSULFATES, PHOSPHATES, HALOGENS, ACETATES
INORGANIC #3
AMIDES, NITRATES (Not AMMONIUM NITRATE) NITRITES, AZIDES
(Store Ammonium Nitrate away from all other substances — ISOLATE IT!)
INORGANIC #1
METALS & HYDRIDES
(Store away from any water)
(Store flammable solids in flammables cabinet)
INORGANIC #4
HYDROXIDES, OXIDES, SILICATES, CARBONATES, CARBON
INORGANIC #7
ARSENATES, CYANIDES, CYANALES
(Store away from any water)
INORGANIC #5
SULFIDES, SELENIDES, PHOSPHIDES, CARBIDES, NITRIDES
INORGANIC #8
BORATES, CHROMATES, MANGANATES, PERMANGANATES
INORGANIC #6
CHLORATES, PERCHLORATES, CHLORITES, PERCHLORIC ACID, PEROXIDES, HYPOCHLORITES, HYDROGEN PEROXIDE
MISCELLANEOUS
INORGANIC #9
ACIDS, except NITRIC
(Acids are best stored in dedicated cabinets)
ACID
Store Nitric Acid away from other acids unless your acid cabinet provides a separate compartment for Nitric Acid.
If possible avoid using the floor

SUGGESTED SHELF STORAGE PATERN — ORGANIC



Section 7
SCIENCE INVENTORY AND STORAGE HAZARDS

This list is derived from a current school supply catalog as well as from chemicals identified as being in high school laboratories. The two complementary organization schemes are included under the "Organization" heading of this list. The colors refer to the J. T. Baker system (page 21) and the numbered inorganic and organic catagories are derived from the Flinn Scientific scheme (page 22). The suggested joint use of these two systems is as follows: (1) Divide the chemicals within their color coding; (2) Separate chemicals within their color according to the inorganic and organic classifications; (3) Separate acids from bases, and oxidizers from reducing agents; and (4) store all compressed gases separately.

Substances listed in Tables 1—5 are also identified in this list. The National Fire Protection Association flammability classifications have been used to designate the "Storage Hazard." They are based on the flashpoints of materials and are the following: if the flashpoint is less than 73°F. the material is highly flammable; between 73°F. and 100°F. the material is flammable; and between 100°F. and 200°F. the material is combustable. TABULATED BELOW ARE STORAGE AND USE HAZARDS FOR EACH CHEMICAL. THE ABSENCE OF A HAZARD OR TOXICITY DESIGNATION IS NOT MEANT TO IMPLY SAFETY. Chemical carcinogens (Tables 2 and 3) should be clearly designated.

SUBSTANCES	ORGANIZATION	STORAGE HAZARDS	AMOUNT
Acetaldehyde (Table 5)	Organic #3, Red	Oxidizes readily in air to form unstable peroxides	
Acetamide (Table 3)	Organic #2, Orange		
Acetanilide	Organic #2, Orange		
Acetic Acid (Table 5)	Organic #1, Red	Combustible, above 103°F. Explosive vapor air mixture (fireproof storage)	
Acetic Anhydride (Table 5)	Organic #1, Red Stripe	Combustible, above 120°F. explosive potential (fireproof storage)	
Aceto Carmine (Natural Red 4)	Miscellaneous, Dye		
Acetone	Organic #4, Red	Highly flammable, vapor air mixture explosive (fireproof, cool storage)	
Aceto-orcein (Orcinol)	Miscellaneous, Orange		
Acetylcholine (as bromide or chloride)	Organic #3		
Acridine Orange (Table 3)	Miscellaneous, Dye		
Acrylonitrile (Inhibited) (Table 2)	Organic #2, Red	Flammable, explosive (fireproof storage)	
Adenine	Organic #2, Orange		
Adrenaline (Table 4)	Organic #2, Orange		
Agar	Miscellaneous, Orange		
Alanine	Organic #2, Orange		
Albumin	Miscellaneous, Orange		
Alizarin Yellow	Miscellaneous, Dye		
Alizarin Red (Red #1)	Miscellaneous, Dye		
Alum	Inorganic #2, Orange	See aluminum ammonium sulfate, aluminum potassium sulfate	
Aluminum Ammonium Sulfate	Inorganic #2, Orange		
Aluminum Chloride, hydrate (Table 5)	Inorganic #2, Orange		
Aluminum Chloride, anhydrous (Table 5)	Inorganic #2, Yellow	Store separately from strong bases, reacts violently with water	

SUBSTANCE	ORGANIZATION	STORAGE HAZARD	AMOUNT
Aluminum Hydroxide	Inorganic #4, Orange		
Aluminum, metal	Inorganic #1, Red		
Aluminum Nitrate	Inorganic #3, Yellow	Enhances combustion of other materials (avoid contamination)	
Aluminum Oxide	Inorganic #2, Orange		
Aluminum Potassium Sulfate	Inorganic #2, Orange		
Aluminum Sodium Sulfate	Inorganic #2, Orange		
Aluminum Sulfate	Inorganic #2, Orange		
Ammonia, liquid (Table 5)	Inorg. #4, White stripe		
Ammonium Acetate	Inorganic, #2, Orange		
Ammonium Bicarbonate	Inorganic #4, Orange		
Ammonium Bichromate (Table 3, 5)	Inorganic #8, Yellow	Many reactions may cause fire and explosion (fireproof storage)	
Ammonium Bromide	Inorganic #2, Orange		
Ammonium Carbonate	Inorganic #4, Orange		
Ammonium Chloride	Inorganic #2, Orange		
Ammonium Chromate (Table 3)	Inorganic #8, Blue		
Ammonium Citrate	Inorganic #8, Orange		
Ammonium Dichromate (Table 3, 5)	Inorganic #8, Yellow	See Ammonium Bichromate	
Ammonium Hydroxide	Inorg. #4, White stripe		
Ammonium Iodide	Inorganic #2, Orange		
Ammonium Metavanadate	Inorganic #2, Blue		
Ammonium Molybdate	Inorganic #8, Orange		
Ammonium Nitrate	Yellow, store separately	Enhances combustion of other substances, strong oxidant (fireproof storage)	
Ammonium Oxalate (Table 5)	Inorganic # 2, White		
Ammonium Persulfate	Inorganic #6, Yellow	Enhances combustion of other substances; explosive reaction with reducing agents, metals	
Ammonium Phosphate	Inorganic #2, Orange		
Ammonium Sulfate	Inorganic #2, Orange		
Ammonium Sulfide	Inorganic #5, Red		
Ammonium Sulfite	Inorganic #2, Orange		
Ammonium Tartrate	Inorganic #2, Orange		
Ammonium Thiocyanate	Inorganic #7, Orange		
Amyl Acetate	Organic #3, Red	Flammable, explosive (fireproof storage)	
N-Amyl Alcohol	Organic #2, Red	Combustible	
Aniline (Table 3)	Organic #2, Red	Combustible; above 160°F. explosive air vapor mixtures (fireproof storage, away from acids, oxidants)	

Section 7, continued — Science Inventory and Storage Hazards

SUBSTANCE	ORGANIZATION	STORAGE HAZARD	AMOUNT
Aniline Blue	Miscellaneous, Dye		
Aniline Hydrochloride (Table 3)	Organic #2, Orange		
Aniline Violet	Miscellaneous, Dye		
Anthracene (Table 3)	Organic #3, Orange		
Antimony	Inorganic #1, Blue		
Antimony Oxide (Trioxide) (Table 3, 5)	Inorganic #4, Blue		
Antimony Pentachloride (Table 5)	Inorganic #2, White		
Antimony Potassium Tartrate	Inorganic #2, White		
Antimony Trichloride (Table 5)	Inorganic #2, White		
Antimony Trisulfide	Inorganic #5, Blue	May enhance combustion of other substances	
Arabinose	Organic #2, Orange		
Arsenic (Table 2)	Inorganic #10, Blue		
Arsenic Chloride (Trichloride) (Table 2)	Inorganic #10, Blue		
Arsenic Pentoxide (Table 2)	Inorganic #10, Blue		
Arsenic Trioxide (Arsenous Acid) (Table 2)	Inorganic #7, Blue		
Asbestos (Table 2)	Inorganic #4, Blue		
Ascorbic Acid	Organic #1, Orange		
Balsam	Organic #2, Orange		
Barford Reagent	Organic #1, Orange	Contains cupric acetate, acetic acid and water	
Barium Acetate	Inorganic #2, Blue		
Barium Carbonate	Inorganic #4, Orange		
Barium Chlorate	Inorganic #6, Yellow	Enhances combustion of other substances; explosive, oxidant	
Barium Chloride	Inorganic #2, Blue		
Barium Hydroxide (Table 4)	Inorganic #4, Blue		
Barium Nitrate	Inorganic #3, Yellow	Enhances combustion of other substances; explosive, oxidant	
Barium Oxalate	Inorganic #2, Blue		
Barium Oxide	Inorganic #4, Blue	Oxidant	
Barium Peroxide	Inorganic #6, Yellow	Enhances the combustion of other substances; many reactions cause fire or explosion	
Barium Sulfate	Inorganic #2, Orange		
Barium Sulfide	Inorganic #5, Blue		
Beal Orcinol Reagent	Organic #2, Red	Contains resorcinol, ethyl alcohol, and ferric chloride	
Beeswax	Miscellaneous, Orange		
Benedict's Solution	Inorganic #2, Orange		

SUBSTANCE	ORGANIZATION	STORAGE HAZARD	AMOUNT
Benzaldehyde	Organic #3, Red	Combustible; above 145°F. explosive air vapor mixtures (fireproof storage)	
Benzene (Table 2)	Organic #3, Red stripe	Highly flammable (fireproof storage)	
Benzidine (Table 2)	Organic #2, Blue		
Benzoic Acid	Organic #1, Orange		
Benzoyl Peroxide (Table 1)	Organic #6, Yellow stripe	Contamination or heating can cause violent decomposition	
Beryllium Carbonate (Table 3)	Inorganic #4, Blue		
Biphenyl (Diphenyl)	Organic #3, Red		
Bismuth Nitrate	Inorganic #3, Yellow	Oxidant	
Bismuth Trichloride (Table 5)	Inorganic #2		
Boric Acid	Inorganic #9, Orange		
Bouin's Fluid	Organic #1, White	Saturated picric acid solution, formalin and acetic acid	
Brilliant Green	Organic #3, Dye		
Bromine (Table 5)	Inorganic #2, Yellow	Many reactions may cause fire and explosion; oxidant	
Bromine Water	Inorganic #2, Yellow	Oxidant	
Bromocresol Green	Miscellaneous, Dye		
Bromocresol Purple	Miscellaneous, Dye		
Bromophenol Blue	Miscellaneous, Dye		
Bromothymol Blue	Miscellaneous, Dye		
Butanol (n-Butyl Alcohol)	Organic #2, Red	Flammable, explosive (fireproof storage)	
Butyric Acid	Organic #1, White	Explosive in above 161°F. air vapor mixtures (fireproof storage)	
Cadmium Acetate	Inorganic #2, Blue		
Cadmium Carbonate	Inorganic #4, Blue		
Cadmium Chloride (Table 2)	Inorganic #2, Blue		
Cadmium, metal (Table 2)	Inorganic #1, Blue		
Cadmium Nitrate	Inorg. #3, Yellow stripe	Oxidant	
Cadmium Oxide	Inorganic #4, Blue		
Cadmium Sulfate (Table 2)	Inorganic #2, White		
Calcium	Inorganic #1, Red	Many reactions may cause fire or explosion	
Calcium Acetate	Inorganic #2, Orange		
Calcium Bromide	Inorganic #2, Orange		
Calcium Carbide (Table 5)	Inorganic #5, Red	Reaction with water may cause fire and explosion	
Calcium Carbonate	Inorganic #4, Orange		
Calcium Chloride	Inorganic #2, Orange		
Calcium Dioxide	Inorganic #4, Yellow		
Calcium Fluoride (Table 5)	Inorganic #2, Orange		

SUBSTANCE	ORGANIZATION	STORAGE HAZARD	AMOUNT
Calcium Hydroxide	Inorganic #4, Orange		
Calcium Hypochlorite	Inorganic #6, Yellow	Enhances combustion of other substances; oxidant	
Calcium Nitrate	Inorganic #3, Yellow	Enhances combustion of other substances; oxidant	
Calcium Oxide (Table 5)	Inorganic #4, Orange		
Calcium Phosphate	Inorganic #2, Orange		
Calcium Sulfate	Inorganic #2, Orange		
Camphor	Organic #4, Red	Combustible; above 150°F. explosive vapor air mixtures	
Carbolfuchsin (Ziehl's Stain)	Organic #2		
Carbolic Acid (Phenol)	Organic #8, Blue		
Carbon	Inorganic #10, Orange		
Carbon Dioxide	Miscellaneous	Solid can cause frostbite	
Carbon Disulfide (Table 1)	Organic #7, Red	Highly flammable, explosive (fireproof storage under water or inert gas)	
Carbon Tetrachloride (Table 2)	Organic #4, Blue		
Carborundum	Inorganic #4, Blue		
Carmine	Miscellaneous, Dye		
Carnoy Fixative (mixture of alcohol, acetic acid and chloroform)	Organic #2, Red	Flammable	
Casein	Miscellaneous, Orange		
Catechol (1,2-dihydroxy-benzene) (Table 5)	Organic #8, Red	Combustible	
Ceric Sulfate	Inorganic #2, Yellow	Fire risk in presence of organic substances	
Charcoal	Inorganic #10, Red		
Chloral Hydrate	Controlled Substance Blue	Should not be stored on school premises	
Chloretone (Chlorobutanol)	Organic #2, Blue		
Chlorine (Tables 4,5)	Bottled gas, Yellow	Many reactions may cause fire and explosion	
Chlorine Water	Inorganic #2, Yellow		
Chlorobenzene	Organic #4, Red	Combustible; above 84°F. explosive vapor air mixtures (fireproof storage)	
Chloroform (Table 2)	Organic #4, Blue		
Chorionic Gonadatropin	Miscellaneous, Orange		
Chromium (Table 2)	Inorganic #1, Blue		
Chromium Acetate	Inorganic #2, Blue		
Chromium Chloride	Inorganic #2, Orange		
Chromium Nitrate	Inorganic #3, Yellow	Strong Oxidant	
Chromium VI Oxide (Table 2)	Inorganic #4, Blue	Oxidant	

Section 7, continued — Science Inventory and Storage Hazards

SUBSTANCE	ORGANIZATION	STORAGE HAZARD	AMOUNT
Chromium (III) Potassium Sulfate	Inorganic #2, Orange		
Chromium Trioxide (Table 2)	Inorganic #4, Yellow	Many reactions may cause fire and explosion; strong oxidant	
Cobalt (Table 3)	Inorganic #1, Orange	Dust is flammable	
Cobalt Chloride	Inorganic #2, Blue		
Cobalt Nitrate	Inorganic #3, Yellow	Enhances the combustion of other substances; oxidant	
Cobalt Sulfate	Inorganic #2, Orange		
Colchicine (Tables 3, 4)	Organic #8, Blue		
Cupric Acetate	Inorganic #2, Orange		
Cupric Bromide (Table 5)	Inorganic #2, Orange		
Cupric Carbonate	Inorganic #4, Orange		
Cupric Chloride (Table 5)	Inorganic #2, Orange		
Cupric Nitrate (Table 5)	Inorganic #3, Yellow	Strong oxidant	
Cupric Oxide	Inorganic #4, Orange		
Cupric Sulfate (Table 5)	Inorganic #2, Orange		
Cyclohexane	Organic #3, Red	Highly flammable (fireproof storage)	
Cyclohexene	Organic #3, Red	Highly flammable (fireproof storage, add inhibitor)	
Deoxyribonucleic Acid	Organic #1, Orange		
Dextrin Starch	Miscellaneous, Orange		
Dextrose	Miscellaneous, Orange		
Diastase of Malt	Miscellaneous, Orange		
P-Dichlorobenzene (Table 5)	Organic #4, Red	Combustible; above 150°F. explosive air vapor mixtures (fireproof storage)	
Dichloroethane (Table 3)	Organic #4, Red	See ethylene dichloride	
Dichloroindophenol Sodium Salt	Organic #8		
Dichloromethane	Organic #4, Blue	See methylene chloride	
Dichlorophenol (Table 5)	Organic #8, Blue		
Diethyl Phthalate	Organic #4, Red	Combustible	
Digitonin	Organic #3		
Diisopropyl ether (Table 1)	Organic #4, Red	Explosive	
N,N Dimethylaniline	Organic #2, Red	Combustible; above 145°F. explosive vapor air mixtures (fireproof storage)	
Dimethylglyoxime	Organic #2		
1,4-Dioxane (P-Dioxane) (Table 3)	Organic #4, Red	Flammable; may develop explosive peroxides (fireproof storage)	
Diphenylamine	Organic #2, Orange		
Dipotassium Chromate	Inorganic #8, Yellow	Oxidant	
EDTA	Organic #1, Orange		

SUBSTANCE	ORGANIZATION	STORAGE HAZARD	AMOUNT
Eosin	Miscellaneous,		
Epinephrine	Organic #2, Orange	See adrenaline	
Epsom Salt	Inorganic #2, Orange	See magnesium sulfate	
Erythrosine	Miscellaneous, Dye		
Ether, Ethyl (Table 1)	Organic #4, Red	Highly flammable, explosive, forms peroxides	
Ethyl Acetate	Organic #4, Red	Flammable, explosive (fireproof storage)	
Ethyl Alcohol	Organic #2, Red	Flammable	
Ethylene Dichloride (Table 3)	Organic #4, Red	Flammable	
Ethylene Glycol	Organic #2, Orange		
Ethylene Oxide (Table 2)	Organic #5, Red	Highly flammable (fireproof storage)	
Ethyl Methacrylate (Table 5)	Organic #3, Red	Flammable	
F.A.A. Solution	Organic #2, Red	Contians formaldehyde, ethyl alcohol and acetic acid	
Fehling's Solution A	Inorganic #2, Orange		
Fehling's Solution B	Inorganic #4		
Ferric Acetate	Inorganic #2, Orange	Combustible	
Ferric Ammonium Acetate	Inorganic #2, Orange		
Ferric Ammonium Citrate	Inorganic #2, Orange		
Ferric Ammonium Sulfate	Inorganic #2, Orange		
Ferric Chloride (Table 5)	Inorganic #2, Orange		
Ferric Nitrate	Inorganic #3, Yellow	Oxidant	
Ferric Oxide	Inorganic, #4, Orange		
Ferric Phosphate	Inorganic, #2, Orange		
Ferric Sulfate	Inorganic #2, Orange		
Ferrous Ammonium Sulfate	Inorganic #2, Orange		
Ferrous Chloride	Inorganic #2, Orange		
Ferrous Nitrate	Inorganic #3, Orange		
Ferrous Oxide	Inorganic #4, Orange		
Ferrous Sulfate	Inorganic #2, Orange		
Ferrous Sulfide	Inorganic #5, Orange		
Feulgen Stain	Miscellaneous, Dye	See Schiff Reagent	
Flagella Stain	Miscellaneous, Dye	See Loeffler's Stain	
Fluorescein	Organic #8		
Formaldehyde (Table 3)	Organic #3, Red		
Formalin (Table 3)	Organic #3	37%-50% solution of formaldehyde	
Formic Acid	Organic #1, Red	Above 156°F. explosive vapor air mixtures	
Fructose	Miscellaneous, Orange		
Fuchsin	Miscellaneous, Orange		

SUBSTANCE	ORGANIZATION	STORAGE HAZARD	AMOUNT
Fumaric Acid	Organic #1	Combustible	
Gasoline	Organic #3, Red	Highly flammable	
Gelatin	Miscellaneous, Orange		
Gentian Violet	Miscellaneous, Orange	See Methyl Violet	
Gibberellic Acid	Organic #1, Orange		
Giemsa Stain	Organic #2, Dye		
Gilson Fluid	Organic #2	Contains acetic acid, nitric acid, ethyl alcohol, and zinc chloride	
Glucose	Organic #2, Orange		
Glycerine	Organic #2, Orange	See Glycerol	
Glycerol	Organic #2, Orange		
Gold Foil	Inorganic #1, Orange		
Gram's Iodine Stain	Miscellaneous, Dye		
Graphite	Inorganic #1, Red		
Gum Arabic	Organic #1, Orange		
Gum Tragacanth	Organic #2, Orange		
Gypsum	Inorganic #2, Orange	See Calcium Sulfate	
Hayem's Solution	Inorganic #2, Blue	Contains mercuric chloride, sodium chloride, and sodium sulfate	
Helium	Bottled Gas		
Hematoxylin	Organic #2, Blue		
Heptane	Organic #3, Red	Flammable; explosive vapor air mixtures	
Hexachlorophene [2,2-Methylenebis (3,4,6 trichlorophenol)] (Table 5)	Organic #8, Blue		
Hexane	Organic #3, Red		
Holtfreter's Solution	Inorganic #2, Orange	Contains sodium chloride, potassium chloride, calcium chloride, sodium bicarbonate	
Hydroiodic Acid	Inorganic #9, White		
Hydrochloric Acid (Table 5)	Inorganic #9, White		
Hydrofluoric Acid (Table 5)	Inorganic #9, White		
Hydrogen	Bottled Gas, Red	Highly flammable, explosive	
Hydrogen Peroxide, 30% (Table 5)	Inorganic #6, Yellow	Enhances combustion of other substances, possible explosive mixed with other substances	
Hydrogen Sulfide (Table 5)	Inorganic #5, Red	Highly flammable, explosive gas	
Hydroquinone (Tables 3, 5)	Organic #3, Red		
Indigo	Miscellaneous, Dye		
Indigo Carmine (Table 3)	Miscellaneous, Dye		
Indolacetic Acid (Table 3)	Organic #1		
Indolphenol Sodium Salt	Inorganic #8		

SUBSTANCE	ORGANIZATION	STORAGE HAZARD	AMOUNT
Iodine (Table 5)	Inorganic #2, White		
Iron Acetate	Inorganic #2, Orange	See Ferric Acetate	
Iron, metal	Inorganic #1, Orange		
Iron Pyrite	Inorganic #2, Orange	See Ferrous Sulfide	
Isoamyl Alcohol	Organic #2, Red	Combustible	
Isobutyl Alcohol	Organic #2, Red	Combustible, explosive above 82°F.	
Isopentyl Alcohol	Organic #2, Red	See Isoamyl Alcohol	
Isopropyl Alcohol	Organic #2, Red	Flammable	
Janus Green B	Miscellaneous, Dye		
Kaolin	Inorganic #4, Orange		
Kerosene	Organic #3, Red	Combustible; above 110°F. vapor air mixtures are explosive	
Lactic Acid	Organic #1, White		
Lactose	Miscellaneous, Orange		
Lauric Acid	Organic #1	Combustible	
Lead Acetate (Table 3)	Inorganic #2, Blue		
Lead Arsenate (Table 2)	Inorganic #7, Blue		
Lead Carbonate (Table 5)	Inorganic #4, Blue		
Lead Chloride	Inorganic #2, Blue	Oxidant	
Lead Dioxide	Inorganic #4, Yellow	Enhances the combustion of other substances; oxidant; reacts violently	
Lead Iodide	Inorganic #2, Blue		
Lead, metal	Inorganic #1, Orange		
Lead Monoxide (Litharge)	Inorganic #4, Blue		
Lead Nitrate	Inorganic #3, Yellow	Enhances combustion of other substances; oxidant	
Lead Oxide	Inorganic #4, Blue	Oxidant; strong reactant	
Lead Peroxide	Inorganic #4, Yellow	See Lead Dioxide	
Lead Sulfate	Inorganic #2, White		
Lead Sulfide (Galena)	Inorganic #5, Blue		
Lead Tetraoxide	Inorganic #4, Blue	See Lead Oxide	
Lime Water	Inorganic #4, Orange	See Calcium Hydroxide	
Linseed Oil	Organic #2, Red		
Lithium Carbonate	Inorganic #4, White		
Lithium Chloride	Inorganic #2, Orange		
Lithium Hydroxide	Inorganic #4, White	Reacts violently with acids	
Lithium, metal (Table 5)	Inorganic #1, Red stripe	Flammable; reacts violently with water, oxidants (fireproof storage)	
Lithium Nitrate	Inorganic #3, Yellow	Oxidant	
Lithium Sulfate	Inorganic #2, Orange		
Litmus	Miscellaneous		

SUBSTANCE	ORGANIZATION	STORAGE HAZARD	AMOUNT
Loeffler's Flagella Stain	Organic #2	Contains fuchsin, ethyl alcohol and aniline	
Logwood Extract (Hematin)	Organic #2		
Luminol	Miscellaneous		
Lugol's Iodine	Inorganic #2, Blue		
Lycopodium Powder	Miscellaneous	Explosive as dust	
Lye	Inorg. #4, White stripe	See Sodium Hydroxide	
Magnesium Acetate	Inorganic #2, Orange		
Magnesium Bromide	Inorganic #2, Orange		
Magnesium Carbonate	Inorganic #4, Orange		
Magnesium Chloride	Inorganic #2, Orange		
Magnesium, metal	Inorganic #1, Red	Highly flammable in powder form; explosive	
Magnesium Nitrate	Inorganic #3, Yellow	Enhances combustion of other substances; oxidant	
Magnesium Oxide	Inorganic #4, Orange		
Magnesium Sulfate	Inorganic #2, Orange		
Magnesium Trisilicate	Inorganic #4, Orange		
Malachite Green	Miscellaneous		
Maleic Acid	Organic #1, Red	Combustible	
Malonic Acid	Organic #1, White		
Maltose	Miscellaneous, Orange		
Manganese Bromide (Manganous Bromide)	Inorganic #2, Orange		
Manganese Chloride (Manganous Chloride)	Inorganic #2, Orange		
Manganese Carbonate	Inorganic #4, Orange		
Manganese Dioxide	Inorganic #4, Yellow	Enhances combustion of other substances; many reactions may cause fire and explosion	
Manganese, metal	Inorganic #1, Red stripe	Dust is flammable	
Manganese Nitrate (Manganous Nitrate)	Inorganic #3, Yellow	Oxidant	
Manganese Oxide (Manganous Oxide)	Inorganic #4, Orange		
Manganese Sulfate (Manganous Sulfate)	Inorganic #2, Orange		
Mayer's Fluid	Inorganic #2	Contains potassium phosphate, magnesium sulfate, ammonium nitrate, calcium phosphate	
Mercuric Chloride (Table 4)	Inorganic #2, Blue		
Mercuric Iodide (Table 4)	Inorganic #2, Blue		
Mercuric Nitrate (Table 4)	Inorg. #3, Yellow stripe	Enhances combustion of other substances; strong oxidant	

Section 7, continued — Science Inventory and Storage Hazards

SUBSTANCE	ORGANIZATION	STORAGE HAZARD	AMOUNT
Mercuric Oxide (Table 4)	Inorganic #4, Blue		
Mercuric Sulfate (Table 4)	Inorganic #2, Blue	Decomposes on exposure to light	
Mercuric Sulfide	Inorganic #5		
Mercurous Chloride	Inorganic #2, Blue		
Mercurous Nitrate	Inorg. #3, Yellow stripe		
Mercurous Oxide	Inorganic #4, Yellow	Oxidant	
Mercury Bichloride	Inorganic #2, Blue	See Mercuric Chloride	
Mercury, metal (Table 4)	Inorganic #1, Blue	Toxic Vapors	
Methanol, Methyl Alcohol	Organic #2, Red	Flammable; vapor air mixture explosive (fireproof storage, separate from oxidants)	
Methyl Cellulose	Miscellaneous, Blue		
Methylene Blue	Miscellaneous, Orange		
Methylene Chloride (Table 3)	Organic #4, Blue		
Methyl Ethyl Ketone (Table 5)	Organic #2, Red	Highly flammable; vapor air mixtures explosive (fireproof storage, separate from oxidants)	
Methyl Iodide	Organic #4, Blue		
Methyl Methacrylate (Inhibited) (Table 5)	Organic #3, Red stripe	Flammable; vapor air mixture explosive (fireproof storage, cool)	
Methyl Orange	Miscellaneous		
Methyl Red	Miscellaneous, Orange		
Methyl Salicylate (Table 5)	Organic #3, Orange		
Methyl Sulfoxide (Dimethyl Sulfoxide)	Organic #4, Orange		
Methyl Violet	Miscellaneous		
Mineral Oil	Organic #3, Red		
Molasses	Miscellaneous, Orange		
Monochloroacetic Acid	Organic #1, White		
Naphthalene (Table 5)	Organic #2, Red stripe		
2-Naphthol (B-Naphthol)	Organic #2	Combustible	
Nessler's Reagent	Inorganic #2, Blue		
Nickel (II) Acetate (Table 3)	Inorganic #2, Blue		
Nickel (II) Ammonium Sulfate	Inorganic #2, Blue		
Nickel (II) Carbonate	Inorganic #6, Blue		
Nickel Chloride	Inorganic #2, Blue		
Nickel Hydroxide	Inorganic #4, Blue		
Nickel, metal (Table 2)	Inorganic #1, Orange		
Nickel Nitrate	Inorg. #3, Yellow stripe	Oxidant	
Nickel Oxide	Inorganic #4, Blue		
Nickel Sulfate	Inorganic #2, Blue		
Nicotine Sulfate (Table 4)	Organic #2, Blue		

SUBSTANCE	ORGANIZATION	STORAGE HAZARD	AMOUNT
Nicotinic Acid (Niacin)	Organic #1, Blue		
Nigrosine Black	Miscellaneous		
Ninhydrin	Organic #2, Blue		
Nitric Acid (Table 5)	Inorganic #3, Yellow	Many reactions may cause explosion; oxidant	
Nitrobenzene	Inorganic #4, Red		
Nitrobenzeneazoresorcinol	Organic #8	Combustible	
Nitrogen	Bottled Gas		
P-Nitrophenol (Table 4)	Organic #8, Yellow	Strong oxidant	
Nucleic Acid	Organic #1, Orange		
Oleic Acid	Organic #1, Orange		
Olive Oil	Miscellaneous, Orange		
Orange IV (Torpeolin 00)	Miscellaneous		
Orcein Staining Solution	Miscellaneous	Contains orcein, hydrochloric acid and ethylanol. Flammable liquid	
Osmium Tetroxide (Table 3)	Inorganic #4, Blue	Vapors are highly irritant	
Oxalic Acid (Table 5)	Organic #1, White	Separate from oxidants and strong bases	
Oxygen	Bottled gas	Fire and explosion risk	
Pancreatin	Miscellaneous, Orange		
Paraffin	Miscellaneous, Orange		
Peanut Oil	Miscellaneous, Orange		
Pentane	Organic #3, Red	Highly flammable; vapor air mixture explosive (fireproof storage)	
Perchloric Acid (Table 5)	Inorganic #6, Yellow		
Petroleum Ether	Organic #4, Red	Highly flammable	
Phenolphthalein	Miscellaneous, Orange		
Phenyl Salicylate (Salol)	Organic #3	Combustible	
Phosphoric Acid	Organic #1, White		
Phosphorus (Red)	Inorg. #10, Red stripe	Separate from oxidants	
Phosphorus (White) (Tables 4,5)	Inorg. #10, Red stripe	Flammable; ignites upon contact with air	
Phosphorus Pentoxide (Tables 4,5)	Inorganic #10, Yellow	Many reactions may cause fire or explosion	
Phthalic Anhydride (Table 5)	Organic #1, White		
Picric Acid (Table 1)	Organic #8, Red	Explosive, if dry	
Potassium Bicarbonate	Inorganic #4, Orange		
Potassium Bisulfate	Inorganic #2, Orange		
Potassium Bitartrate	Inorganic #2, Orange		
Potassium Bromate	Inorganic #2, Yellow		
Potassium Bromide	Inorganic #2, Orange		
Potassium Carbonate	Inorganic #4, Orange		

SUBSTANCE	ORGANIZATION	STORAGE HAZARD	AMOUNT
Potassium Chlorate	Inorganic #6, Yellow	Enhances combustion of other substances; if contaminated may explode from shock or mechanical friction	
Potassium Chloride	Inorganic #2, Orange		
Potassium Chromate (Tables 3,5)	Inorganic #8, Blue		
Potassium Cyanide (Tables 4,5)	Inorg. #7, White stripe		
Potassium Dichromate	Inorganic #8, Yellow	Strong oxidant	
Potassium Ferricyanide	Inorganic #7, Orange		
Potassium Ferrocyanide	Inorganic #7, Orange		
Potassium Fluoride (Table 5)	Inorganic #2, Blue		
Potassium Hydroxide (Table 5)	Inorg. #4, White stripe	Reacts violently with acids	
Potassium Iodate	Inorganic #8, Yellow	Enhances combustion of other substances; strong oxidant	
Potassium Iodide	Inorganic #2, Orange		
Potassium, metal (Tables 1,5)	Inorg. #1, Red stripe	Combustible; many reactions may cause fire and explosion; reacts violently with water (fireproof storage separately under paraffin or oil)	
Potassium Nitrate	Inorganic #3, Yellow	Enhances combustion of other substances; oxidant; violent reactant	
Potassium Oxalate	Inorganic #2, Blue		
Potassium Oxide	Inorganic #4, White		
Potassium Periodate, meta (Table 4)	Inorganic #6, Yellow	Enhances combustion of other substances; many reactions may cause fire or explosion	
Potassium Permanganate (Tables 3,5)	Inorganic #8, Yellow	Enhances combustion of other substances; many reactions may cause fire and explosion; powerful oxidant; violent reactant	
Potassium Phosphate	Inorganic #2, Orange		
Potassium Pyrosulfate	Inorganic #2, Orange		
Potassium Sodium Tartrate	Inorganic #2, Orange		
Potassium Sulfate	Inorganic #2, Orange		
Potassium Sulfide	Inorganic #5, Red	May ignite spontaneously on contact with air; flammable; explosive on heating (fireproof storage)	
Potassium Tartrate	Inorganic #2, Orange		
Potassium Thiocyanate	Inorg. #2, Yellow stripe		
Propane	Bottled gas, Red	Highly flammable; explosive air vapor mistures	
Propionic Acid	Organic #1, Red	Combustible	
Propyl Alcohol	Organic #2, Red	Flammable; vapor-air mixtures explosive	
Pyridine	Organic #2, Red	Flammable; vapor-air mixtures explosive (fireproof storage separate from oxidants)	

SUBSTANCE	ORGANIZATION	STORAGE HAZARD	AMOUNT
Pyrogallic Acid (Table 3)	Organic #4, Blue		
Quinine Sulfate	Organic #2		
Resorcinol	Organic #2, Red		
Ringer's Solution	Miscellaneous		
Rosin	Miscellaneous, Red		
Safranine	Miscellaneous, Dye		
Salicylic Acid (Table 3)	Organic #1, Orange	Dust explosive	
Sand	Miscellaneous, Orange		
Schiff Reagent	Organic #2	Contains fuchsin, sodium bisulfite and hydrochloric acid	
Selenium	Inorganic #1, Orange		
Sesame Oil	Organic #4, Orange		
Silicic Acid	Inorganic #9, Orange		
Silica Gel	Miscellaneous, Orange		
Silicon, metal	Inorganic #1, Orange		
Silver Acetate	Inorganic #2, Blue		
Silver Chloride	Inorganic #2, Blue		
Silver Cyanide (Table 4)	Inorganic #7, Blue		
Silver Iodide	Inorganic #2, Blue		
Silver, metal	Inorganic #1, Blue		
Silver Nitrate (Table 3)	Inorganic #3, Yellow	Many reactions may cause fire and explosion; violent reaction with organic substances	
Silver Oxide	Inorganic #4, Orange	Oxidant	
Silver Sulfate	Inorganic #2, Blue		
Sodium Acetate	Inorganic #2, Orange		
Sodium Arsenate (Table 2)	Inorganic #7, Blue		
Sodium Arsenite (Table 2)	Inorganic #7, Blue		
Sodium Azide (Table 3)	Inorganic #3, Blue	Explosion possible from concussion, friction (fireproof storage, mix with water, 20%)	
Sodium Bicarbonate	Inorganic #4, Orange		
Sodium Bismuthate	Inorganic #7, Orange		
Sodium Bisulfate	Inorganic #2, Orange		
Sodium Bisulfite	Inorganic #2, Orange		
Sodium Borate	Inorganic #8, Orange		
Sodium Bromide	Inorganic #2, Orange		
Sodium Carbonate	Inorganic #4, Orange		
Sodium Chlorate	Inorganic #6, Yellow	Many reactions may cause fire and explosion; strong oxidant	
Sodium Chloride	Inorganic #2, Orange		
Sodium Chromate	Inorganic #8, Yellow	Oxidant	

SUBSTANCE	ORGANIZATION	STORAGE HAZARD	AMOUNT
Sodium Citrate	Inorganic #8, Orange		
Sodium Cyanide (Tables 4,5)	Inorganic #7, Blue		
Sodium Dichromate (Table 3)	Inorganic #8, Yellow	Many reactions may cause fire and explosion; oxidant	
Sodium Dithionite	Inorganic #2, Red stripe	Oxidant	
Sodium Ferrocyanide (Table 5)	Inorganic #7, Orange		
Sodium Fluoride	Inorganic #2, Blue		
Sodium Hydroxide (Table 5)	Inorg. #4, White stripe	Reacts violently with acid	
Sodium Hydrosulfite	Inorganic #2, Red stripe	See Sodium Dithionite	
Sodium Hypochlorite	Inorganic #6, Orange	Reacts violently with acids; forms toxic fumes in presence of ammonia	
Sodium Hyposulfate	Inorganic #2, Orange	See Sodium Dithionite	
Sodium Iodate	Inorganic #2, Yellow		
Sodium Iodide	Inorganic #2, Orange		
Sodium Lauryl Sulfate	Inorganic #2		
Sodium Metabisulfite	Inorganic #2, Orange		
Sodium, metal (Table 5)	Inorganic #1, Red stripe	Combustible; many reactions may cause fire and explosion; violent reaction with water (fireproof storage; separate under paraffin oil or kerosene from all substances)	
Sodium Metaphosphate	Inorganic #2, Orange		
Sodium Molybdate	Inorganic #2, Orange		
Sodium Nitrate (Table 3)	Inorganic #3, Yellow	Enhances the combustion of other substances; oxidant	
Sodium Nitrite (Table 3)	Inorganic #3, Yellow	Many reactions may cause fire and explosion	
Sodium Oxalate	Inorganic #2, Blue		
Sodium Perborate	Inorganic #8, Orange	Oxidant	
Sodium Permanganate	Inorganic #8, Yellow	Oxidant	
Sodium Peroxide	Inorg. #6, Yellow stripe	Many reactions may cause fire and explosion; reacts violently with water	
Sodium Phosphate	Inorganic #2, Orange		
Sodium Pyrophosphate	Inorganic #2, Orange		
Sodium Salicylate	Organic #1, Orange		
Sodium Silicate	Inorganic #2, Orange		
Sodium Silicofluoride (Disodium Hexafluorosilicate) (Table 5)	Inorganic #4		
Sodium Sulfate	Inorganic #2, Orange		
Sodium Sulfide (Anhydrous) (Table 5)	Inorganic #5, Red	Store separately from acids, oxidants, dry	
Sodium Sulfite	Inorganic #2, Orange		
Sodium Tartrate	Inorganic #2, Orange		

SUBSTANCE	ORGANIZATION	STORAGE HAZARD	AMOUNT
Sodium Tetraborate	Inorganic #8, Orange	See sodium borate	
Sodium Thiocyanate	Inorganic #7, Orange		
Sodium Thiosulfate	Inorganic #2, Orange		
Sodium Tungstate	Inorganic #2, Orange		
Stannic Chloride (Table 5)	Inorganic #2, White		
Stannic Oxide	Inorganic #2, Orange		
Stannous Chloride	Inorganic #2, Orange		
Starch	Miscellaneous, Orange		
Stearic Acid	Organic #1, Orange		
Strontium	Inorganic #1, Red stripe		
Strontium Bromide	Inorganic #2, Orange		
Strontium Chloride	Inorganic #2, Orange		
Strontium Nitrate	Inorganic #3, Yellow		
Succinic Acid	Organic #1, Orange		
Sucrose	Miscellaneous, Orange		
Sudan Black B	Miscellaneous, Dye		
Sudan III	Miscellaneous, Dye		
Sudan IV	Organic #2, Dye		
Sugar	Miscellaneous, Orange		
Sulfamic Acid	Organic #1, White	Separate from strong bases	
Sulfanilic Acid	Organic #1, White		
Sulfur	Inorganic #10, Orange		
Sulfur Black Dye	Inorganic #10, Dye		
Sulfur Blue Dye	Inorganic #10, Dye		
Sulfur Yellow Dye (Napthol yellow, citronin)	Inorganic #10, Dye		
Sulfuric Acid (Table 5)	Inorganic #9, White	Many reactions may cause fire and explosion; water reactive	
Talc	Miscellaneous, Orange		
Tannic Acid	Organic #1, Orange		
Tartaric Acid	Organic #1, Orange		
Terpineol	Organic #2, Orange		
Testosterone	Miscellaneous, Blue		
Tetrahydrofuran	Organic #4, Red	Highly flammable, vapor air mixtures are explosive; also forms explosive peroxides	
Thermite Igniting Mixture	Inorganic #4, Red	Contains Fe_2O_3 and Al; Flammable Burning difficult to stop once started (fireproof storage)	
Thioacetamide (Table 3)	Organic #2, Blue		
Thiourea	Organic #2, Blue		

SUBSTANCE	ORGANIZATION	STORAGE HAZARD	AMOUNT
Thymol Blue	Miscellaneous		
Thyroxine	Miscellaneous, Orange		
Tin, metal	Inorganic #1, Orange	Combustible as dust	
Titanium, metal (Table 5)	Inorganic #1, Red	Combustible as dust	
Titanium Dioxide (Titanium Oxide)	Inorganic #4, Orange	Combustible; many reactions may cause fire and explosion; store under inert gas	
Titanium Trichloride (Table 5)	Inorganic #2, Red		
Toluene (Tables 3,5)	Inorganic #3, Red	Flammable; vapor-air mixtures explosive (fireproof storage, separate from H_2SO_4)	
O-Toluidine (Table 2)	Organic #2, Blue	Separate from Acids	
Tricane Methane Sulfonate	Organic #2		
Trichloroacetic Acid	Organic #1, White		
Trichlorotrifluoroethane (Table 5)	Organic #4, Orange		
Triethanolamine	Organic #2, Orange		
Trimethylpentane	Organic #3, Red	Flammable	
Triphenyl Tetrazolium Chloride	Miscellaneous		
Trisodium Phosphate	Inorganic #2, White	Separate from strong acids	
Tumeric Powder	Organic #2, Orange		
Tungsten, metal	Inorganic #1, Orange	Dust is flammable	
Turpentine (Table 5)	Organic #2, Red	Combustible (fireproof storage, spearate from oxidants)	
Ultramarine Blue	Miscellaneous		
Uranyl Nitrate	Inorganic #3, Yellow	Strong oxidant	
Urea	Organic #2, Orange		
Urethane (Table 3)	Organic #2, Orange		
Vegetable Oil	Organic #2, Orange		
Wood's metal	Inorganic #1, Orange	Contains bismuth, lead, tin, cadmium	
Wright's Stain Solution	Miscellaneous, Red	Flammable	
Xylene	Organic #3, Red	Combustible; above 81°F. explosive vapor-air mixtures (fireproof storage)	
Yeast	Miscellaneous, Orange		
Zenker's Fluid	Inorganic #2, Blue	Contains mercuric chloride, potassium dichromate, sodium sulfate and acetic acid	
Zeolite	Inorganic #4, Orange		
Zinc Acetate	Inorganic #2, Orange		
Zinc Carbonate	Inorganic #2		
Zinc Chloride	Inorganic #2, White		
Zinc, metal	Inorganic #1, Red stripe	Combustible as dust (fireproof storage separated from oxidants)	

Section 7, continued — Science Inventory and Storage Hazards

SUBSTANCE	ORGANIZATION	STORAGE HAZARD	AMOUNT
Zinc Nitrate	Inorganic #3, Yellow	Enhances combustion of other substances	
Zinc Oxide	Inorganic #4, Orange		
Zinc Stearate	Inorganic #2, Orange		
Zinc Sulfate	Inorganic #2, Orange		
Zinc Sulfide	Inorganic #5, Orange		
Zirconium Nitrate	Inorganic #3, Yellow		

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This form is available to Science Teachers if they choose to use it.

SCIENCE INVENTORY FORM

(To be filled out upon completion of an inventory of all chemicals in the school.)

The Science Inventory of _____ School

Address _____

_____

This is to certify that the science inventory (attached) of this school has been completed as of _____ day of _____, 19_____. Time: _____

_____
(Signature of Science Teacher)

In general, chemicals with the following functional groups are prone to instability:

O – O	(peroxide)	– N =	(imino)	– ONO_2	(nitrate ester)
– NO_2	(nitro)	– N_3	(azide)	– $NHNO_2$	(nitramine)
– N = N –	(Azo)	– N = O	(nitroso)	– N – NO_2	(nitroamine)

These reagents should be dated, handled according to prescribed storage conditions, and disposed of after use.

The following list provides some additional information dealing with specific chemical incompatibilities. It is not all-inclusive. The list is reprinted by permission from **Better Science Through Safety** by Jack A. Gerlovich and Gary E. Downs, ©1981 by the Iowa State University Press, 2121 South State Ave., Ames, IA 50010.

CHEMICAL	CHEMICALS INCOMPATIBLE WITH
Acetic Acid	Nitric acid, peroxides, permanganates, ethylene glycol, hydroxyl compounds, perchloric acid, or chromic acid
Acetone	concentrated sulfuric and nitric acid
Acetylene	Bromine, chlorine, fluorine, copper, silver, mercury and their compounds
Alkali metals	Carbon tetrachloride*, carbon dioxide, water, halogens
Alkaline metals (powdered aluminum or magnesium)	Carbon tetrachloride*, or other chlorinated hydrocarbons, halogens, carbon dioxide
Ammonia, anhydrous	Mercury, hydrogen fluoride, calcium hypochlorite, chlorine, bromine
Ammonium Nitrate	Acids, flammable liquids, metal powders, sulfur, chlorates, any finely divided organic or combustible substance
Aniline	Nitric acid and hydrogen peroxide
Bromine, Chlorine	Ammonia, petroleum gases, hydrogen, sodium, benzene, finely divided metals
Carbon, activated	Calcium hypochlorite and all oxidizing agents
Chlorates	Ammonium salts, acids, metal powders, sulfur, and finely divided organic or combustible substance
Chromic Acid	Glacial acetic acid, camphor, glycerin, naphthalene, turpentine, lower molecular weight alcohols, and many flammable liquids
Copper	Acetylene and hydrogen peroxide
Flammable liquids	Ammonium nitrate, chromic acid, hydrogen peroxide, sodium peroxide, nitric acid, and the halogens
Hydrocarbons (propane, benzene, gasoline)	Fluorine, chlorine, bromine, sodium peroxide and chromic acid
Hydrofluoric Acid	Ammonia (aqueous or anhydrous)
Hydrogen Peroxide	Most metals and their salts, alcohols, organic substances, any flammable substances
Hydrogen Sulfide	Oxidizing gases, fuming nitric acid
Iodine	Acetylene, ammonia, hydrogen
Mercury	Acetylene, ammonia
Nitric Acid (concentrated)	Acetic acid, hydrogen sulfide, flammable liquids and gases, chromic acid, aniline
Oxygen	Oils, grease, hydrogen, flammable liquids, solids and gases

*It is recommended that carbon tetrachloride be removed from high school labs. It is a probable human carcinogen.

CHEMICAL	CHEMICALS INCOMPATIBLE WITH
Perchloric Acid	Acetic anhydride, bismuth and its alloys, alcohols, paper, wood, and other organic materials
Phosphorus Pentoxide	Water
Potassium Chlorate	Sulfuric and other acids, any organic material
Potassium Permanganate	Sulfuric acid, glycerine, ethylene glycol
Silver	Acetylene, ammonia compounds, oxalic acid, tartaric acid
Sodium Peroxide	Ethyl or methyl alcohol, glacial acetic acid, carbon disulfide, glycerine, ethylene glycol, ethyl acetate
Sulfuric Acid	Potassium chlorate, potassium perchlorate, potassium permanganate, similar compounds of other light metals

WORKSHEET FOR HAZARDOUS PROPERTIES OF A SUBSTANCE

(To assist science teachers in researching the properties of a chemical and deciding how to use, store, or dispose of it.)

Date:_____

Chemical Name: _____ Formula _____

CAS Registry No. _____ Amount stored in school _____

Synonyms:_____

PHYSICAL PROPERTIES:

Gas _____ Liquid _____ Solid _____ Color _____ Odor _____ Solubility _____

Boiling Point _____ Melting Point _____ Flash Point _____

Cup open_____ Cup Closed_____ Others:_____

CHEMICAL PROPERTIES:

Reactive with substances _____

Carcinogen _____ Human _____ Animal _____ Explosive _____ Flammable _____

Severe Poison_____ Oxidizer_____ Other:_____

Storage Instructions: _____

Quantity Restrictions: _____

Disposal and Spill Procedures _____

Site Approved for Disposal _____

Publications Recommending Use of Substance in the School Science Program:

_____

_____

Safety Facilities Necessary to Use and Store this Substance:_____

_____

Recommendations of Health Authorities:

Continue to use _____
Purchase _____
Discontinue using _____
Dispose of by Health Agency or
Licensed Commercial Company_____

Section 8
RECOMMENDATIONS FOR TEXTBOOK PUBLISHERS AND SCIENCE SUPPLY COMPANIES

To enable science teachers to provide a safe program of instruction with reduced exposure to hazardous substances authors and science textbook publishers should be encouraged to do the following:

1. Give safety instructions to the student at the beginning of each laboratory experiment.
2. Conclude each student laboratory experiment with instructions for cleanup and disposal of substances left over.
3. Provide instructions for labeling all containers of substances used or produced in the experiment.

Science supply companies should be encouraged to do the following:

1. Supply the smallest quantity required if a hazardous substance is needed for class use, shipped to arrive at the school shortly before the experiment is to be performed.
2. Provide a safety data sheet with each hazardous substance shipped to the school.
3. Advise the school if an ordered substance is restricted or extremely hazardous and suggest a substitute experiment.

Section 9
RESOURCES

Several resources exist to help science teachers deal with chemicals in the school laboratory:

— **American Chemical Society Health and Safety Referral Service.**

This service will refer inquirers to appropriate resources to help find answers to questions about health and safety. The resources used include books, periodical articles, films, educational programs, and government agencies and other organizations oriented to health and safety.

The Health and Safety Referral Service may be reached through:

Barbara Gallagher (Librarian)
American Chemical Society
1155 Sixteenth St., N.W.
Washington, D.C. 20036
(202) 872-4511

— **Toxicologists in the State Departments of Health.**

Most State Departments of Health have toxicologists who can help answer questions about chemical safety. You may find these toxicologists by contacting your State Department of Health.

— **State Science Supervisors in the State Departments of Education.**

Most State Departments of Education have a State Science Supervisor who is responsible for safety in the school science laboratory. The Council of State Science Supervisors (which participated in the development of this publication) may be reached through:

Council of State Science Supervisors
Rt. 2, Box 637
Lancaster, VA 22503
(804) 462-7371

Individual State Science Supervisors may be contacted through your State Department of Education.

— Information similar to the "Chemical Fact Sheet" prepared by the New York State Department of Health, Bureau of Toxic Substance Assessment (Empire State Plaza, Tower Building, Albany, NY 12237) may be obtained from the local state department of health. Although this information applies to workplace exposure resulting from processing, manufacturing, storing or handling rather than for the public at large, it is useful to the secondary school science teacher.

— State health authorities may offer consultation as new evidence becomes available on substances, which may justify classifying a substance as too hazardous to store or use.

— Current references on science laboratory safety topics are available in the libraries of health agencies, colleges, and/or industries.

— Disposal procedures for substances are available from regional offices of the U.S. Environmental Protection Agency.

— Material Safety Data Sheets may be obtained from chemical supply companies on request. They are federally mandated for use by manufacturers and contain relevant product and health and safety information for those who handle and use chemicals.

— Other possible contacts might include the State Department of Labor, insurance companies with a strong industrial hygiene department, local colleges and universities which include a school of Public Health with a toxicology department, local American Chemical Society chapters, and independent consultants.

— Additional copies of this document are available from the offices of the U.S. Consumer Product Safety Commission.

— **Regional Offices of the U.S. Environmental Protection Agency.**

The Regional Offices of the Environmental Protection Agency (EPA) may have information about the disposal procedures recommended when hazardous chemicals must be removed from the school laboratory. You may contact the Regional Office of EPA in your area, using the following list:

U.S. Environmental Protection Agency

Regional Offices

Environmental Protection Agency
Region 1
John F. Kennedy Federal Building
Boston, MA 02203
(617) 223-7210

Environmental Protection Agency
Region 2
26 Federal Plaza
New York, NY 10278
(212) 264-2525

Environmental Protection Agency
Region 3
Curtis Building
6th and Walnut St.
Philadelphia, PA 19106
(215) 597-9814

Environmental Protection Agency
Region 4
345 Courtland St., NE
Atlanta, GA 30365
(404) 881-4727

Environmental Protection Agency
Region 5
230 South Dearborn St.
Chicago, IL 60604
(312) 353-2000

Environmental Protection Agency
Region 6
1201 Elm Street
Dallas, TX 75270
(214) 767-2600

Environmental Protection Agency
Region 7
324 East 11th St.
Kansas City, MO 64106
(816) 926-3720

Environmental Protection Agency
Region 8
1860 Lincoln St.
Denver, CO 80295
(303) 837-3895

Environmental Protection Agency
Region 9
215 Fremont St.
San Francisco, CA 94105
(415) 974 8153

Environmental Protection Agency
Region 10
1200 Sixth Avenue
Seattle, WA 98101
(206) 442-5810

Section 10
SOURCES CONSULTED

1. American Chemical Society Committee on Chemical Safety. **Safety in Academic Chemistry Laboratories,** 3rd Edition, author published, 1979.

2. American Chemical Society's Office of Federal Regulatory Programs. **RCRA and Laboratories.** Department of Public Affairs, American Chemical Society, 1155 Sixteenth St., N.W., Washington, D.C. 20036

2. American Conference Governmental and Industrial Hygienists. **Threshold Limit Values for Chemical Substances and Physical Agents in the Work Environment with Intended Changes for 1983-84.** Cincinnati, OH: ACGIH, 1983

3. Armour, N. A., Browne, L. M., Weir, G. L. **Hazardous Chemicals (Information and Disposal Guide,** Department of Chemistry, University of Alberta, Edmonton, Alberta T6G-2G2.

5. Bretherick, L. **Hazards in the Chemical Laboratory,** 3rd ed., London Chemical Society, Royal Society of Chemistry Publishers, London, 1981.

6. **Catalog Handbook of Fine Chemicals.** Milwaukee, WI: Aldrich Chemical Co., 1982-83.

7. **Chemical Catalog Reference Manual**. Batavia, IL: Flinn Scientific, Inc., 1983.

8. Committee on Hazardous Substances in the Laboratory, Assembly of Mathematical and Physical Sciences, National Research Council. **Prudent Practices for Handling Chemicals in Laboratories,** National Academy Press, Washington, D.C., 1981.

9. Committee on Hazardous Substances in the Laboratory, Commission on Physical Sciences, Mathematics and Resources, National Research Council. **Prudent Practices for Disposal of Chemicals from Laboratories,** National Academy Press, Washington, D.C., 1983

10. **Concise Chemical and Technical Dictionary.** New York: Chemical Publishing Co., Inc., 1974

11. Cralley, L. J. and Cralley, L. V. (Ed.) **Patty's Industrial Hygiene and Toxicology.** New York: John Wiley & Sons, 1979.

12. Dutch Association of Safety Experts, Dutch Chemical Industry Association, Dutch Safety Institute. **Handling Chemicals Safely.** Amsterdam: Amro Bank, 1980.

13. Fawcett, Howard H. and Wood, William S. **Safety and Accident Prevention in Chemical Operations.** 2nd ed., New York: John Wiley & Sons, 1982.

14. Green, Michael E. and Turk, Amos. **Safety in Working with Chemicals.** New York: MacMillan, 1978.

15. **A Handbook of Laboratory Solutions.** New York: Chemical Publishing Co., 1968.

16. Hawley, G. **The Condensed Chemical Dictionary.** 10th ed. New York: Van Nostrand Reinhold Co., 1981.

17. International Agency for Research on Cancer, World Health Organization. **Evaluation of the Carcinogenic Risk of Chemicals to Humans.** Lyon, France: IARC, 1982

18. The International Technical Information Institute. **Toxic and Hazardous Industrial Chemicals Safety Manual for Handling and Disposal with Toxicity and Hazard Data.** Japan: ITII, 1978.

19. Manufacturing Chemists Association. **Guide for Safety in Chemical Laboratories.** 2nd ed., New York: Van Nostrand Reinhold, 1972.

20. **The Merck Index.** 9th ed., Rahway, New Jersey: Merck & Co., 1976.

21. National Fire Protection Association. **Manual of Hazardous Chemical Reactions.** Boston, MA, 1980.

22. National Institute for Occupational Safety and Health. **Manual of Safety and Health Hazards in the School Science Laboratory.** Washington, D.C.: U.S. Department of Health and Human Services, 1980.

23. National Institute for Occupational Safety and Health. **Carcinogens: Regulation and Control.** Cincinnati, OH, 1977.

24. National Institute for Occupational Safety and Health. **Occupational Health Guidelines for Chemical Hazards.** Publ. No. 81-123, Washington, D.C.: U.S. Department of Health and Human Services, January 1981.

25. National Institute for Occupational Safety and Health. **Pocket Guide to Chemical Hazards.** 4th Printing, Publ. No. 78-210, Washington, D.C.: U.S. Department of Health and Human Services, 1981.

26. National Institute for Occupational Safety and Health. **1981-82 Registry of Toxic Effects of Chemical Substances.** Vols. I and II, Publ. No. 81-116: Washington, D.C.: U.S. Department of Health and Human Services, June, 1983.

27. National Institute for Occupational Safety and Health. **Safety in the School Science Laboratory.** Cincinnati, OH, November, 1980.

28. Oliver and Boyd, **Hazardous Chemicals: A Manual for Schools and Colleges.** Edinburgh: Scottish Schools Science Equipment Research Center, 1981.

29. "Safety in the Chemical Laboratory" Volumes 1, 2, 3, 4, **Journal of Chemical Education,** American Chemical Society, Division of Chemical Education, Easton, PA 18042.

30. U.S. Consumer Product Safety Commission. **System for Tracking the Inventory of Chemicals.** Washington, D.C.: USCPSC, 1983.

31. U.S. Public Health Service, Department of Health and Human Services. **First and Second Annual Report on Carcinogens.** Vol. I and II, National Toxicology Program, 1981-82.

32. U.S. Public Health Service, Department of Health and Human Services. Review of Current DHHS, DOE, and EPA Research Related to Toxicology. Washington, D.C.: National Toxicology Program, 1983.

33. Young, J. A., Safety Tips "Academic Laboratory Waste Disposal: Yes, You Can Get Rid of That Stuff Legally!" **Journal of Chemical Education,** vol. 60, no. 6, June, 1983.

34. DATA RETRIEVAL SERVICES:

    Hazard Line.
    Occupational Health Services, Inc.
    Toxicology Data Base (TDB)

35. FILMS:

    Laboratory Safety, Part I, Richmond, VA: Virginia Department of Education, 1969.

    School Lab Safety, West Hollywood, CA: Handel Film Corporation, 1979.

    Eye and Face Protection, Cleveland, OH: Edward Fiel Production

    Flash Point, Chicago, IL, International Film Bureau

    Using a Fire Extinguisher, Boston, MA: NFPA

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Expiration Date: 9/30/84
OMB Number 3041-0052

This information collection is authorized under 15 USC 2051.
This form has been approved by OMB (3041-0052), and its submission to the CPSC is entirely voluntary.

HAZARDOUS SUBSTANCES REMOVED FROM THE SCHOOL

Indentify only your State:_____

SUBSTANCE	CAS NO.	AMOUNT	REMOVED BY	DATE	DISPOSAL LOCATION

Send a copy of this completed form to:

U.S. Consumer Product Safety Commission
Rm. 412-EX-O
Washington, D.C. 20207

Expiration Date: 9/30/84
OMB Number 3041-0052

This information collection is authorized under 15 USC 2051.
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Section 11
EVALUATION

Identify only by State _____

In order to help us evaluate this publication, please respond to the following questions and return to:

U.S. Consumer Product Safety Commission
Rm. 412 — EX-O
Washington, D.C. 20207

PLEASE RESPOND TO EACH ITEM BY CIRCLING THE APPROPRIATE NUMBER ON EACH OF THE FOLLOWING SCALES:

1. Did this document give you new information about the hazards associated with commonly-used school laboratory chemicals?

1	2	3	4
No new information	Little	Some	Much new information

2. What porportion of the chemicals in your laboratory were addressed by this document?

1	2	3	4
Very few chemicals	Some	About half	Most of the chemicals

3. Please rate the utility of the design of this document.

1	2	3	4
Not useful	Somewhat useful	Useful	Very useful

4. Please rate the utility of the references in this document in helping you obtain additional information.

1	2	3	4
Not useful	Somewhat useful	Useful	Very useful

5. How much do you think this document will help improve the safe teaching of science?

1	2	3	4
None	Little	Some	A great deal

6. Will this document cause some teachers to restrict the use of certain chemicals in their science lab activities?

1	2	3	4
No restrictions	A few	Some	Many chemicals will be restricted

7. Did this document improve your understanding of what makes specific substances hazardous?

1	2	3	4
No improvement	Little	Some	Considerable improvement

8. Will the information provided in this document improve your ability to use these chemical substances in a safer manner?

1	2	3	4
No improvement	Little	Some	Considerable improvement

(Over)

9. Is the information provided in this document sufficient for you to decide whether or not to use certain chemicals?

1	2	3	4
Not sufficient	Barely	Somewhat	Completely sufficient

10. Do you believe that special "inservice" training sessions are necessary to get maximum value from this document?

1	2	3	4
Not necessary	Little	Somewhat	Very necessary

11. Would you recommend this document to other science teachers?

1	2	3	4
No	Perhaps	Probably	Yes

12. This document will be of greatest value to the following teachers:
(Please circle the most appropriate response/s)

BIOLOGY CHEMISTRY PHYSICS EARTH SCIENCE
ELEMENTARY LIFE SCIENCE PHYSICAL SCIENCE

Comments: _____

_____

When mailing this evaluation form, please be sure to include a list of "Hazardous Substances Removed from the School." (p. 55)

For further information, write:
U.S. Consumer Product Safety Commission
Washington, D.C. 20207

Toll Free Hotline: 800-638-CPSC or 800-638-2772
TTY (including Alaska and Hawaii) 800-638-8270
TTY Maryland only 800-492-8104

Regional Office Addresses

MIDWESTERN REGIONAL OFFICE
230 South Dearborn Street, Rm. 2945
Chicago, Illinois 60604
312-353-8260

SOUTHWESTERN REGIONAL OFFICE
1100 Commerce Street, Rm. 1C10
Dallas, Texas 75242
214-767-0841

SOUTHEASTERN REGIONAL OFFICE
800 Peachtree Street, N.E., Suite 210
Atlanta, Georgia 30308
404-881-2231

WESTERN REGIONAL OFFICE
555 Battery Street, Rm. 416
San Francisco, California 94111
415-556-1816

NORTHEASTERN REGIONAL OFFICE
6 World Trade Center
Vesey Street, 6th Floor
New York, New York 10048
212-264-1125

CPSC Resident Posts

Boston, Massachusetts; Bridgeport, Connecticut; Buffalo, New York; Charlotte, North Carolina; Cincinnati, Ohio; Cleveland, Ohio; Denver, Colorado; Detroit, Michigan; Honolulu, Hawaii; Houston, Texas; Indianapolis, Indiana; Kansas City, Missouri; Los Angeles, California; Miami, Florida; Milwaukee, Wisconsin; New Orleans, Louisiana; Orlando, Florida; Philadelphia, Pennsylvania; Phoenix, Arizona; Pittsburgh, Pennsylvania; Portland, Oregon; Rockville, Maryland; San Juan, Puerto Rico; Seattle, Washington; St. Louis, Missouri; St. Paul, Minnesota; Tulsa, Oklahoma.

The U.S. Consumer Product Safety Commission (CPSC) is an independent regulatory agency charged with reducing unreasonable risks of injury associated with consumer products. The U.S. Consumer Product Safety Commission is headed by five Commissioners appointed by the President with the advice and consent of the Senate.

Nancy Harvey Steorts, Chairman

Saundra Brown Armstrong, Commissioner
Terrence M. Scanlon, Commissioner
Stuart M. Statler, Commissioner